103(a) as unpatentable over Wallace as applied to claim 16, and further in view of U.S. patent 5,818,092 to Bai et al. (herein "Bai").

Addressing now the rejection of claims 1-4, 7-9, 12, and 13 under 35 U.S.C. § 103(a) as unpatentable over Wallace, that rejection is traversed by the present response.

Claim 1 is amended to clarify a structure of the insulating film. As recited in claim 1, the semiconductor device recited therein includes a semiconductor substrate and a circuit element using an insulating film formed on the semiconductor substrate. Also, the insulating film contains a silicon compound containing oxygen and a metal compound containing a metal other than silicon and oxygen. Further, nano-crystals are formed in the insulating film, and a particle diameter of the nano-crystals is within a range of between 1 nm and 10 nm.

The Amendment filed March 25, 2003, provided details to differences between the claims and the teachings in Wallace. That Amendment has now been requested to be entered by the present Request for Continued Examination (RCE) papers. The arguments presented in that Amendment are still believed to apply to the claims as currently written, and thus the claims are believed to clearly distinguish over the teachings in Wallace in view of the arguments presented in the Amendment filed March 25, 2003.

However, the Advisory Action of April 9, 2003, which indicated the Amendment filed March 25, 2003, would not be entered, also states:

> With respect to the size of the nano-crystal, note that the ratio of silicon in the silicide (Si/(Si+ metal)) of Wallace appears to fall within the limit (15%-60%) as disclosed. Therefore, the size of the nano-crystal of Wallace should fall within the claimed range as discussed in the rejection. Applicants fail to show the contrary.

The above-noted grounds for the rejection, and also the grounds for the rejection noted in the outstanding Office Action, take the position that the device of Wallace inherently would include nano-crystals with a particle diameter within a range of between 1 nm and 10 nm.

In response to that basis for the rejection noted in the outstanding Office Action and the Advisory Action, applicants submit that the device of Wallace does not inherently include nano-crystals with the claimed particle diameter size within a range of between 1 nm and 10 nm, as discussed in even further detail below.

The insulating film of the claimed semiconductor device has nano-crystals formed therein. As discussed in the present specification at page 11, lines 4-6, the insulating film is "***not amorphous***, and nano-crystals are formed in the mixed film" (emphasis added). It is also noted in the specification at page 11, lines 7-8, that "[v]ery small grains of single crystals are collectively called nano-crystals".

In the claimed invention, to obtain nano-crystals having a particle diameter within a range of between 1 nm and 10 nm the insulating film is an oxide. In each example described in the original specification the insulating film is made from an oxide. The applicants note that if nitrogen is contained in the insulting film, crystallization is inhibited and the insulating film becomes amorphous. As a result, applicants note that if nitrogen is contained in the insulating film nano-crystals having a particle diameter within a range of between 1 nm and 10 nm cannot be obtained.

Attached to the present response is a sheet of photographs from a microscope view to support this point. As shown in the attachment figures, (a), (b), (c) and (d) are results of crystallization in an insulating film when nitrogen contents are 0 at%, 5 at%, 16 at%, and 30 at%.

As shown in figure (a) in the attached photograph sheet, if there is no nitrogen content crystallization occurs. On the other hand as the nitrogen in the insulating film increases, as shown in photographs (b), (c), and (d), the crystallization is inhibited.

Further, applicants note that if nitrogen is contained in the insulating film, a fixed electric charge is formed. This results in problems such as a shift of a threshold level of a transistor and degradation of a driving force.

As noted above the claims require the formation of nano-crystals in the insulating film. The particular construction of the claimed invention makes it possible to suppress leakage current derived from a grain boundary and to suppress non-uniformity in a threshold value and a driving force. As a result, in the claimed invention it is possible to improve characteristics of an MOS transistor, etc. As a result the claimed insulating film can be suitably used for a gate insulating film of a MOSFET. Such benefits are also discussed in the present specification at page 16, line 26, to page 17, line 6.

Wallace cannot inherently result in the formation of nano-crystals with the claimed particle size diameter within a range of between 1 nm and 10 nm as Wallace discloses an insulating film containing nitrogen. As evidenced by the enclosed figures the use of an insulating film including nitrogen results in drawbacks, namely inhibiting crystallization, that the claimed invention can specifically avoid. The introduction of nitrogen in the insulating film as in Wallace does not inherently lead to nano-crystals within a range of between 1 nm and 10 nm of a particle diameter.

Wallace specifically discloses at column 8, lines 4-14, forming a metal silicon-***oxynitride*** layer 36 by oxy-nitridation. Thus, Wallace clearly discloses the use of nitrogen in an insulating film.

As noted above in detail applicants submit that it is not possible to create nano-crystals having a particle diameter within a range of between 1 nm and 10 nm in an oxynitride layer. As a result, applicants respectfully submit that Wallace does not in fact result in a device with nano-crystals having a particle diameter within a range of between 1 nm and 10 nm in the metal silicon-oxy nitride layer 36.

Applicants believe that the above comments clearly show that the device of Wallace does not inherently result in an insulating film including nano-crystals with the claimed particle diameter within a range of between 1 nm and 10 nm, in contrast to the basis for the outstanding rejection.

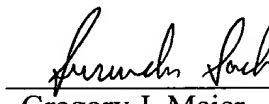
In such ways, each of the claims clearly distinguishes over the teachings in Wallace.

As each of the other rejections is based on the teachings in Wallace, it is respectfully submitted that each of the other rejections is also traversed by the present response.

As no other issues are pending in this application, it is respectfully submitted that the present application is now in condition for allowance, and it is hereby respectfully requested that this case be passed to issue.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER, & NEUSTADT, P.C.



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Amendment Filed on: HEREWITH

IN THE CLAIMS

1. (Twice Amended) A semiconductor device comprising:

a semiconductor substrate, and

a circuit element using an insulating film formed on said semiconductor substrate,

said insulating film containing a silicon compound containing [at least one element selected from the group consisting of an] oxygen [and a nitrogen], and a metal compound containing a metal other than silicon and [at least one element selected from the group consisting of an] oxygen [and a nitrogen], said insulating film further comprising nano-crystals, a particle diameter of said nano-crystals being within a range of between 1 nm and 10 nm.

16. (Amended) A semiconductor device comprising:

a semiconductor substrate;

source and drain regions formed apart from each other in said semiconductor substrate;

a gate insulating film formed between said source and drain regions, said gate insulating film containing a silicon compound containing [at least one element selected from the group consisting of an] oxygen [and a nitrogen], and a metal compound containing a metal other than a silicon and [at least one element selected from the group consisting of an] oxygen [and a nitrogen], said insulating film further comprising nano-crystals, a particle diameter of said nano-crystals being within a range of between 1 nm and 10 nm; and

a gate electrode formed on said gate insulating film.

Nitrogen suppresses the phase separation

Annealing : 1000℃ N2 30sec